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TITLE: COATING SOLUTION FOR SUNLIGHT-SHIELDING FILM
AND
SUNLIGHT- SHIELDING FILM OBTAINED THEREFROM

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ABSTRACT:

PROBLEM TO BE SOLVED: To provide a coating solution, that can form, by a simple coating method, a film high in transmittance of light in a visible light region and low in reflectance, low in transmittance of light in a near infrared region, and able to be so controlled that the surface resistance value of the film is $10^6 \Omega/\text{square}$ or over, and also provide a sunlight-shielding film obtained by use of the coating solution.

SOLUTION: The coating solution for sunlight-shielding film comprises fine particle of a hexaboride and fine particles of indium tin oxide(ITO)

or fine
particles of antimony tin oxide(ATO) at a ratio by weight ranging
(0.1:99.9) to
(90:10). The hexaboride is represented by XB6 (wherein X=Y, La, Ce,
Nd, Sm,
Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Sr or Ca). The sunlight-
shielding film is
obtained by applying the coating solution on one or both sides of a
resin film.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the coating liquid and the solar radiation screen obtained by this for applying apertures, such as a car, a building, an office, and a general residence, a show window, the lamp for lighting, etc. to base materials which need solar radiation electric shielding, such as glass and transparenance resin, and forming a solar radiation screen.

[0002]

[Description of the Prior Art] Considering as the solar radiation screen which removes and decreases the heat component from sunlight etc., and forming conventionally, the metallic-oxide metallurgy group thin film which reflects the wavelength of visible and an infrared region in a resin film or a glass front face was performed. Here, the metallic material which has free electrons, such as metallic oxides, such as FeOX, CoOX, CrOX, and TiOX, and Ag, Au, aluminum, so much as a typical inorganic system ingredient was chosen.

[0003] With the resin film, the object which added the near-infrared electric shielding agent of an organic system in the resin binder was often used. The phthalocyanine system metallurgy group complex system is known by the typical near infrared ray absorbent.

[0004]

[Problem(s) to be Solved by the Invention] However, in the above-mentioned conventional inorganic material, in addition to the near infrared ray greatly contributed to a thermal effect especially by sunrays, the light of a light field also had the property reflected or absorbed in coincidence, and an appearance [GIRAGIRA / appearance] like a mirror was given, the fine sight was spoiled and it had the fault to which light permeability falls.

[0005] Since the high permeability of a light field is needed when using these inorganic materials for the transparenance base material used for a residence, a building, a vehicle, etc., actuation of making thickness very thin is needed. Therefore, very thin film called 10nm level had to be formed using the physical forming-membranes methods, such as the spray burning method, a CVD method, a spatter, and vacuum evaporation technique. For this reason, large-scale equipment and a vacuum facility were needed, membrane formation cost was high and the problem was in productivity and large area-ization.

[0006] Furthermore, in these inorganic materials, there were many to which membranous conductivity becomes high, the electric wave of the car-navigation system which carried the antenna in a cellular phone, or in the car [TV reception and in the car] etc. was reflected, it became non-receipt and there was a fault, such as causing an electromagnetic interference in a circumference area.

[0007] On the other hand, in the near infrared ray electric shielding agent of the above-mentioned conventional organic system, compared with the ingredient of an inorganic system, degradation by heat or humidity was remarkable, and weatherability had a fatal fault. Moreover, when it was going to make light permeability high, the solar radiation electric shielding property fell, and if a solar radiation electric shielding property is conversely made high, light permeability will have fallen.

[0008] There were comparatively few absorption of light of a light field and reflection factors, and since

they were low although antimony content tin oxide (ATO) and tin content indium oxide (ITO) were known as a solar radiation shielding material with high transparency to people's eyes, and a lot of [in order to make Japanese ***** appear] ingredients were required for them, its film using this was very expensive. [of the solar radiation electric shielding force per unit mass]

[0009] Moreover, since the solar radiation electric shielding property of ATO has low free electron concentration, its electric shielding force of near-infrared light is weak, and it is not enough. [of a property] Even if it formed these film by the physical forming-membranes method, membranous conductivity went up, and there was a fault which carries out reflective active jamming of the electric wave.

[0010] Then, this invention solves the fault of an ingredient conventionally [above-mentioned], and the permeability of the light of a light field is high, a reflection factor is low, the permeability of the light of a near infrared region is low, and it is using ATO, and ITO and 6 borides collectively. Rather than each independent use, raise a solar radiation electric shielding property, decrease ATO and the amount of ITO used, and ingredient cost is reduced. And it aims at offering coating liquid for the more controllable film than [106ohms /] ** forming a membranous surface-electrical-resistance value by the simple applying method, without using the physical forming-membranes method, and the solar radiation screen using this.

[0011]

[Means for Solving the Problem] Paying attention to 6 borides which hold a free electron so much, suddenly the maximum of permeability to a light field by this invention persons' ultrafine-particle-izing this, and producing the film which combined with ATO or ITO and was distributed, in order to attain the above-mentioned purpose both It came to complete a header and this invention for the phenomenon of discovering absorption and reflection strong against the near-infrared region near a light field, and coming to have the minimum of permeability.

[0012] That is, the coating liquid for solar radiation screens of this invention is characterized by containing 6 boride particle, and a tin addition indium oxide (ITO) particle or a stibiation tin oxide (ATO) particle in the range of - (0.1:99.9) (90:10) by the weight ratio.

[0013] However, 6 borides mean one or more sorts in what is expressed with XB6 (X=Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Sr or calcium).

[0014] Moreover, other coating liquid for solar radiation screens of this invention is characterized by containing further one or more sorts of the particle chosen from the group of SiO₂, TiO₂, ZrO₂, aluminum₂O₃, and MgO with the configuration of one of the above.

[0015] Moreover, other coating liquid for solar radiation screens of this invention is characterized by including in a binder one or more sorts chosen from the group of ultraviolet-rays hardening resin, electron ray hardening resin, room-temperature-setting resin, and thermoplastics further with the configuration of one of the above.

[0016] Moreover, the solar radiation screen of this invention is characterized by applying the coating liquid of the configuration of one of the above to one side or both sides of a resin film.

[0017] Moreover, other solar radiation screens of this invention are further characterized by a resin film consisting of one resin of polycarbonate system resin, Pori (meta) acrylic ester system resin, saturated polyester resin, and annular olefin system resin with the above-mentioned configuration.

[0018] Moreover, other solar radiation screens of this invention are further characterized by carrying out the laminating of adhesives and the mold releasing film in one field of the film of the above-mentioned configuration.

[0019] A rebound ace court layer may be further given to the field of another side of the above-mentioned film. The coating liquid of said configuration of having included in the binder one or more sorts chosen from the group of ultraviolet-rays hardening resin, electron ray hardening resin, room-temperature-setting resin, and thermoplastics may be used for this rebound ace court layer.

[0020] According to the solar radiation screen of above-mentioned this invention, a surface-electrical-resistance value is controllable 106ohms / more than **.

[0021]

[Embodiment of the Invention] YB6, LaB6, CeB6, PrB6, NdB6, SmB6, EuB6, GdB6, TbB6, DyB6, HoB6, ErB6, TmB6, YbB6, LuB6, SrB6, and CaB6 are mentioned to 6 borides used for this invention.

[0022] Although the particles of these 6 boride are a dark purple-blue color and which green powder, if particle size distributes a sufficiently small particle in a thin film compared with light wavelength, light permeability will produce them. However, infrared light covers. These ingredients hold many free electrons and this is considered because absorption by the interband transition between 4f-5d, and an electronic-electron and an electron phonon interaction exists in a near infrared region.

[0023] According to the experiment, the distributed film of these 6 boride particle has the maximal value, while permeability is the wavelength of 400-700nm, and it has the minimal value with a wavelength of 700-1800nm in between. Light wavelength is 380-780nm, if it takes into consideration that visibility is campanulate [with a peak of near 550nm], by such film, the light will be penetrated effectively, and the other solar radiation will be absorbed and reflected effectively.

[0024] The ITO particle and ATO particle which are used by this invention have large reflection and absorption which the absorption of light and reflection are not almost in a light field, and originates in plasmon resonance in a field 1000nm or more. The lower right serves as ** as these transparency profiles go in a near infrared region to a long wavelength side.

[0025] On the other hand, the transparency pull file of 6 borides has a bottom near 1000nm, and shows an upward slant to the right gradually by the long wavelength side from it. For this reason, by carrying out ***** use of 6 borides, and ITO and ATO, without making it decrease, light permeability becomes possible [covering the sunrays of a near infrared region], and its solar radiation electric shielding property improves rather than it uses it independently, respectively.

[0026] The solar radiation electric shielding capacity per unit weight of 6 borides is very high, and demonstrates the effectiveness by the 1/10 or less amount used as compared with ITO or ATO. Furthermore, by using together with ITO or ATO, only a solar radiation electric shielding property can be raised maintaining fixed light permeability, and cost can also be reduced. Moreover, since the amount of all the particles used is sharply reducible, membranous abrasion strength and weatherability can be raised.

[0027] Since a light field has absorption when the amount used is increased, 6 borides can control absorption of a light field by controlling the addition freely, and can also perform brightness adjustment and application to privacy protection etc.

[0028] The particle size of 6 boride particle has good 200nm or less, and its 100nm or less is preferably good. It is because condensation of the particles in dispersion liquid will become strong, and it will become the cause of sedimentation of a particle, and a larger particle than 200nm or the condensed big and rough particle will serve as a source of light scattering of the film after a paint film and the film will bloom cloudy, if particle diameter becomes larger than 200nm.

[0029] The particle of an ITO particle, an ATO particle, SiO₂, TiO₂ and ZrO₂, aluminum₂O₃, and MgO also has good 200nm or less at the same reason as the above, and its 100nm or less is preferably good. Particles, such as SiO₂, TiO₂, ZrO₂, aluminum₂O₃, and MgO, can use the colloid sol 200nm or less produced by the wet method.

[0030] If a particle distributes in a solution to homogeneity, what kind of approach is sufficient as the distributed approach of a particle, for example, it has approaches, such as a bead mill, a ball mill, a sand mill, and ultrasonic distribution.

[0031] What is necessary is to be able to use for a binder organic binders, such as ultraviolet-rays hardening resin, electron ray hardening resin, room-temperature-setting resin, and thermoplastics, and the organic inorganic hybrid binder which carried out conversion of the inorganic oxides, such as silicon, a zirconium, titanium, and aluminum, to this, and to mix a binder with particle dispersion liquid, or to mix a particle and directly, and just to consider as coating liquid.

[0032] Plates, such as glass and transperence resin, a film, etc. are used for a base material. What is necessary is just to choose the resin film suitable for an application, although a polyethylene terephthalate (PET) film is mentioned to the representation of a transperence resin film base material. Generally a resin film base material is penetrable, and transparent and colorless resin with little

dispersion is suitable, for example, the resin of a polycarbonate system, a Pori (meta) acrylic ester system, an annular olefin system, and a saturated polyester system, polystyrene, a polyvinyl chloride, polyvinyl acetate, etc. are mentioned.

[0033] The front face of a resin film base material is good to perform surface treatment aiming at the improvement in bending with a resin binder. For example, they are corona treatment, plasma treatment, flame treatment, primer layer coat processing, etc.

[0034] When thinking the design nature of a resin film as important, the base material colored beforehand or the ***** (ed) base material can also be used. Moreover, a color pigment and a color may be added in coating liquid.

[0035] In order to stick the film of a resin film base material on glass etc., the laminating of an adhesives layer and the mold releasing film layer may be carried out to an adhesion side. The film simply softened with heating of a dryer may be used so that it may be easy to stick on an aspect of affairs like the back window of an automobile.

[0036] If an ultraviolet-rays electric shielding agent is added in adhesives, a film and the ultraviolet ray degradation of a paint film can be prevented. A benzophenone system ultraviolet ray absorbent, a benzotriazol system ultraviolet ray absorbent, CeO₂, TiO₂, ZnO, etc. are mentioned to an ultraviolet ray absorbent.

[0037] When using ultraviolet-rays hardening resin for a binder, mixture of photopolymerization nature monomers, such as photopolymerization nature oligomer, such as epoxy acrylate, urethane acrylate, polyester acrylate, and polyether acrylate, and monofunctional acrylate, polyfunctional acrylate, can be used as a principal component, and what added optical initiation assistants, such as photoinitiators, such as a benzoin system, an acetophenone system, a thioxanthone system, and a peroxide system, and an amine system, a quinone system, to this can be used. furthermore, thermal polymerization inhibitor, an adhesion grant agent, a CHIKUSO grant agent and a plasticizer, and a ratio -- a reactant polymer and a coloring agent may be added. Film reinforcement can also be further raised by adding the particle of SiO₂, TiO₂, ZrO₂, aluminum₂O₃, and MgO to ultraviolet-rays hardening resin. Moreover, effectiveness with the same said of combining chemically inorganic substances, such as SiO₂, TiO₂, ZrO₂, aluminum₂O₃, and MgO, with the principal component of ultraviolet-rays hardening resin is acquired. By using ultraviolet-rays hardening resin excellent in properties, such as abrasion resistance, a solar radiation electric shielding property and a rebound ace court function can be given at coincidence to a resin film and a resin base material.

[0038] Moreover, if room-temperature-setting resin is used for a binder, apertures, such as the existing residence, a building, and a vehicle, can be coated and it can be made to harden as it is.

[0039] Especially the dispersion medium of a particle is not limited but can be chosen according to spreading conditions, the synthetic-resin binder in a spreading environment and coating liquid, etc. For example, organic solvents, such as water, alcohol, the ether, ester, and a ketone, can be used. If a direct binder is made to distribute a particle, it will become coating liquid of an environment-friendly non-solvent.

[0040] To coating liquid, an acid and alkali may be added if needed, and pH may be adjusted. Moreover, in order to raise the distributed stability of the particle in coating liquid further, various kinds of surfactants, a coupling agent, etc. may be added. Each addition has 50 or less desirable % of the weight to a particle total amount.

[0041] Membranous conductivity is discovered by contact of particles. What is necessary is to isolate a particle in a paint film and just to abolish contact, in order to carry out a membranous surface-electrical-resistance value to more than 106ohms / **. This is controllable at the addition of a binder. Moreover, various coupling agents and a dispersant are made to act on a particle front face, and membranous surface electrical resistance can be controlled also by abolishing contact of particles.

[0042] On a base material, a particle deposits the solar radiation screen of this invention on high density, and it is formed. A binder makes a particle bind to a base material after spreading hardening, and raises a membranous degree of hardness. If a rebound ace court layer is furthermore formed, the binding capacity to a membranous base material, a membranous degree of hardness, and weatherability can be

raised further.

[0043] In order to raise a membranous degree of hardness and abrasion strength, the particle of SiO₂, TiO₂, ZrO₂, aluminum₂O₃, and MgO may be added to coating liquid. These particles are fundamentally transparent and light permeability is not reduced by having added.

[0044] Especially the method of application of coating liquid may not be limited, and as long as a dipping method, the flow coat method, a spray method, the bar coat method, a spin coat method, the GURABIYA coat method, the roll coat method, the screen printing blade coat method, etc. are flatness and the approach of applying to homogeneity thinly about processing liquid, what kind of approach is sufficient as it.

[0045] What is necessary is just to make it harden according to each hardening approach, when using a resin binder. What is necessary is to combine with the resonance wavelength of each photoinitiator, and the target cure rate, and just to choose an ultraviolet ray lamp, if it is ultraviolet-rays hardening resin. As a typical lamp, a low-pressure mercury lamp, a high-pressure mercury lamp, an extra-high pressure mercury lamp, a metal halide lamp, a pulse xenon lamp, an electrodeless discharge lamp, etc. are mentioned. What is necessary is just to make it harden using electron-beam-irradiation equipments, such as a scanning-type and an electron curtain mold, in the case of the resin binder of the electron ray hardening type which does not use a photoinitiator. What is necessary is just to leave it as it is after spreading that what is necessary is just to heat at the target temperature in the case of a heat hardening mold resin binder in the case of room-temperature-setting resin.

[0046] The film of this invention has little reflection in a light field compared with a crystal filling the inside of the film precisely and having a mirror plane-like front face like the oxide thin film formed by the physical forming-membranes method, and the appearance [GIRAGIRA / appearance] is not presented. A luminous reflectance can be easily reduced by forming film of a low refractive index like SiO₂ and MgF on the film to control reflection of a light field further.

[0047] In this invention, since the inorganic material of 6 borides and others is used, membranous weatherability is excellent compared with an organic material, and even if it uses it in the location where sunrays hit, degradation of a color or many functions is hardly produced.

[0048]

[Example] Hereafter, an example and the example of a comparison show this invention to a detail further.

[0049] Example 1 ... 20g [of LaB₆ particles] (90nm of mean diameters) and isobutyl alcohol (IBA) 73g and 7g (Toshiba Silicone silicone coupling agent) of coupling agents for particle distribution were mixed, ball mill mixing was carried out for 200 hours using the zirconia ball with a diameter of 2mm, and the dispersion liquid of LaB₆ particle were produced (A liquid).

[0050] As a binder, the ultraviolet-rays hardening resin (80% of solid content) by the Shin-etsu chemistry company was prepared (B liquid).

[0051] Moreover, 30g [of ITO particles] (70nm of mean diameters) and isobutyl alcohol (IBA) 56g and 14g (silicone coupling agent made from ADEKA) of coupling agents for particle distribution were mixed, ball mill mixing was carried out for 180 hours using the zirconia ball with a diameter of 1mm, and the dispersion liquid of an ITO particle were produced (C fluid).

[0052] It diluted with ethanol, and mixed enough and A liquid, B liquid, and C fluid were used as coating liquid so that it might become the presentation of Table 1. This coating liquid was formed using the bar coating machine to the easily-adhesive side of a PET film (Teijin EPE-50 (50 micrometers in thickness)). The bar coater at this time used No.16. This was put into the 130-degree C dryer, and it heated for about 2 minutes, and with the high-pressure mercury lamp, ultraviolet rays are irradiated, and were stiffened for 1 minute, in the place where the solvent evaporated, and the target film was obtained.

[0053] The permeability of the formed film measures the permeability of 200-1800nm using the Hitachi spectrophotometer, and is JIS. Solar radiation permeability and light permeability were computed according to R3106. Moreover, membranous surface electrical resistance was measured using the surface-electrical-resistance meter by Mitsubishi Petrochemical Co., Ltd. These results are shown in Table 1.

[0054] The property of the film obtained in examples 1-23 and the examples 1-3 of a comparison is also collectively shown in Table 1. Moreover, the transparency profile of this film is shown in drawing 1.

[0055] Examples 2-5 ... It diluted with ethanol, and mixed enough and A liquid, B liquid, and C fluid were used as coating liquid so that it might become the presentation of Table 1. In this, membranes were formed by the same approach as an example 1, and the target film was obtained. The optical property of this film is shown in Table 1.

[0056] Example 1 of a comparison ... It diluted with diacetone alcohol (DAA), and mixed enough, and B liquid and C fluid were used as coating liquid so that it might become the presentation of Table 1. Membranes were formed by the same approach as an example 1 in this, and the target film was obtained. The optical property of this film is shown in Table 1.

[0057] The presentation of an example 1 - an example 5, and the example 1 of a comparison and change of an optical property are shown in drawing 2. It becomes possible to decrease solar radiation permeability further, without lowering light permeability compared with the property of the conventional ITO by carrying out minute amount addition of LaB6 very much, and this drawing shows that the amount of ITO(s) is sharply reducible at this time.

[0058] if the example 1 of a comparison is compared with an example 2 -- LaB6 -- 1.37wt(s)% of all the particles in the film ($** 0.12/(0.12+8.66) \times 100\%$) -- what $(8.66\text{wt}\%/17.0\text{wt}\% \times 0.5)$ light permeability lowered solar radiation permeability three points or more, maintaining to 78%, and ITO concentration was further reduced for in abbreviation one half by having added is understood. It is clearer than this improvement in a solar radiation electric shielding property and that cost reduction can carry out to coincidence further at minute amount addition of LaB6.

[0059] Example 2 of a comparison ... 30g [of ATO particles] (50nm of mean diameters) and isobutyl alcohol (IBA) 55g and 15g (silicone coupling agent made from ADEKA) of coupling agents for particle distribution were mixed, ball mill mixing was carried out for 150 hours using the zirconia ball with a diameter of 1mm, and the dispersion liquid of an ATO particle were produced (D liquid).

[0060] It diluted with DAA, and mixed enough and B liquid and D liquid were used as coating liquid so that it might become the presentation of Table 1. In this, membranes were formed by the same approach as an example 1, and the target film was obtained. The optical property of this film is shown in Table 1.

[0061] Examples 6-9 ... It diluted with isobutyl alcohol, and mixed enough, and A liquid, B liquid, and D liquid were used as coating liquid so that it might become the presentation of Table 1. In this, membranes were formed by the same approach as the example 1 of a comparison, and the target film was obtained. The optical property of this film is shown in Table 1. Moreover, the transparency profile of an example 8 is shown in drawing 1.

[0062] The presentation of the example 2 of a comparison, an example 6 - an example 9 and change of an optical property are shown in drawing 3. It becomes possible to decrease solar radiation permeability further, without lowering light permeability compared with the property of the conventional ATO by carrying out minute amount addition of LaB6 very much, and this drawing shows that the amount of ATO is sharply reducible at this time.

[0063] if the example 2 of a comparison is compared with an example 8 -- LaB6 -- 10.5wt(s)% of all the particles in the film ($** 0.37/(0.37+3.16) \times 100\%$) -- by having added, maintaining to 78%, light permeability lowered solar radiation permeability about two points, and reduced ATO concentration to about 1/3 further $(3.16\text{wt}\%/9.5\text{wt}\% \times 0.33)$ -- things are understood.)

[0064] Example 3 of a comparison ... It diluted with DAA, and mixed enough and A liquid, B liquid, and D liquid were used as coating liquid so that it might become the presentation of Table 1. In this, membranes were formed by the same approach as an example 1, and the target film was obtained. The optical property of this film is shown in Table 1.

[0065] Example 10 ... Room-temperature-setting nature resin (the hybrid system room-temperature-setting resin made from JSR / curing catalyst) was prepared as a binder (E liquid).

[0066] It diluted with DAA, and mixed enough and A liquid, E liquid, and D liquid were used as coating liquid so that it might become the presentation of Table 1. Formed membranes, and will leave it for about one day, it was made to harden at a room temperature by the same approach as an example 1, and

the target film was obtained. The optical property of this film is shown in Table 1.

[0067] Examples 11-15 ... It diluted with DAA, and mixed enough and A liquid, B liquid, and D liquid were used as coating liquid so that it might become the presentation of Table 1. In this, membranes were formed by the same approach as an example 1, and the target film was obtained. The optical property of this film is shown in Table 1. The transparency profile of an example 13 is shown in drawing 1.

[0068] The presentation of the example 3 of a comparison, an example 10 - an example 15 and change of an optical property are shown in drawing 4. Compared with the property of the ATO conventional by carrying out minute amount addition of LaB6 very much, it becomes possible to decrease solar radiation permeability further, without lowering light permeability, and this drawing shows that the amount of ATO is sharply reducible at this time.

[0069] For example, although 23wt% ATO is required in order to consider as 60% of light permeability only by ATO of the example 3 of a comparison if the example 3 of a comparison is compared with an example 13 In the example 13 in which all the particles in the film added LaB6 7.7%, although ATO in coating liquid is below one half of 8.28% and 23.0% of the example 3 of a comparison and is the 60% of the still more nearly same light permeability, solar radiation permeability is reduced by seven points or more. It is clearer than this that improvement in a solar radiation electric shielding property and cost reduction can carry out to coincidence by addition of LaB6.

[0070] Example 16 ... It diluted with DAA, and mixed enough and A liquid, B liquid, and C fluid were used as coating liquid so that it might become the presentation of Table 1. In this, membranes were formed by the same approach as an example 1, and the target film was obtained. The optical property of this film is shown in Table 1.

[0071] An example 16 shows having covered solar radiation efficiently with the comparatively low permeability of 60% for light permeability by mixing LaB6 of a minute amount, and little ITO very much. Since ITO is expensive, coming out so much and making it 60% of visible light transmittance requires cost very much, but although the concentration of ITO is low as it understands, even if it compares with the example 1 of a comparison, the good solar radiation electric shielding property is acquired by addition of LaB6. Moreover, light transmission is changed simply, namely, brightness is changed, and it turns out that application of privacy protection etc. is also possible.

[0072] Example 17 ... 20g [of CeB6 particles] (85nm of mean diameters) and isobutyl alcohol (IBA) 73g and 7g (Toshiba Silicone silicone coupling agent) of coupling agents for particle distribution were mixed, ball mill mixing was carried out for 200 hours using the zirconia ball with a diameter of 2mm, and the dispersion liquid of CeB6 particle were produced (F liquid).

[0073] It diluted with DAA, and mixed enough and B liquid, C fluid, and F liquid were used as coating liquid so that it might become the presentation of Table 1. In this, membranes were formed by the same approach as an example 1, and the target film was obtained. The optical property of this film is shown in Table 1.

[0074] Example 18 ... 20g [of PrB6 particles] (85nm of mean diameters) and isobutyl alcohol (IBA) 73g and 7g (Toshiba Silicone silicone coupling agent) of coupling agents for particle distribution were mixed, ball mill mixing was carried out for 200 hours using the zirconia ball with a diameter of 2mm, and the dispersion liquid of PrB6 particle were produced (G liquid).

[0075] It diluted with DAA, and mixed enough and B liquid, C fluid, and G liquid were used as coating liquid so that it might become the presentation of Table 1. In this, membranes were formed by the same approach as an example 1, and the target film was obtained. The optical property of this film is shown in Table 1.

[0076] Example 19 ... 20g [of NdB6 particles] (85nm of mean diameters) and isobutyl alcohol (IBA) 73g and 7g (Toshiba Silicone silicone coupling agent) of coupling agents for particle distribution were mixed, ball mill mixing was carried out for 200 hours using the zirconia ball with a diameter of 2mm, and the dispersion liquid of NdB6 particle were produced (H liquid).

[0077] It diluted with DAA, and mixed enough and B liquid, D liquid, and H liquid were used as coating liquid so that it might become the presentation of Table 1. In this, membranes were formed by the same approach as an example 1, and the target film was obtained. The optical property of this film is shown in

Table 1.

[0078] Example 20 ... 20g [of GdB6 particles] (mean particle diameter of 85nm) and isopropyl alcohol (IPA) 73g and 7g (Toshiba Silicone silicone coupling agent) of coupling agents for particle distribution were mixed, ball mill mixing was carried out for 200 hours using the zirconia ball with a diameter of 2mm, and the dispersion liquid of GaB6 particle were produced (I liquid).

[0079] It diluted with DAA, and mixed enough and B liquid, D liquid, and I liquid were used as coating liquid so that it might become the presentation of Table 1. In this, membranes were formed by the same approach as an example 1, and the target film was obtained. The optical property of this film is shown in Table 1.

[0080] Example 21 ... 20g [of YB6 particles] (mean particle diameter of 85nm) and isopropyl alcohol (IPA) 73g and 7g (Toshiba Silicone silicone coupling agent) of coupling agents for particle distribution were mixed, ball mill mixing was carried out for 200 hours using the zirconia ball with a diameter of 2mm, and the dispersion liquid of YB6 particle were produced (J liquid).

[0081] It diluted with DAA, and mixed enough and B liquid, C fluid, and J liquid were used as coating liquid so that it might become the presentation of Table 1. In this, membranes were formed by the same approach as an example 1, and the target film was obtained. The optical property of this film is shown in Table 1.

[0082] Example 22 ... 20g [of SmB6 particles] (mean particle diameter of 85nm) and isopropyl alcohol (IPA) 73g and 7g (Toshiba Silicone silicone coupling agent) of coupling agents for particle distribution were mixed, ball mill mixing was carried out for 200 hours using the zirconia ball with a diameter of 2mm, and the dispersion liquid of SmB6 particle were produced (K liquid).

[0083] It diluted with DAA, and mixed enough and B liquid, D liquid, and K liquid were used as coating liquid so that it might become the presentation of Table 1. In this, membranes were formed by the same approach as an example 1, and the target film was obtained. The optical property of this film is shown in Table 1.

[0084] Example 23 ... 20g [of EuB6 particles] (85nm of mean diameters) and diacetone alcohol (DAA) 73g and 7g (Toshiba Silicone silicone coupling agent) of coupling agents for particle distribution were mixed, ball mill mixing was carried out for 200 hours using the zirconia ball with a diameter of 2mm, and the dispersion liquid of EuB6 particle were produced (L liquid).

[0085] It diluted with DAA, and mixed enough and B liquid, D liquid, and L liquid were used as coating liquid so that it might become the presentation of Table 1. In this, membranes were formed by the same approach as an example 1, and the target film was obtained. The optical property of this film is shown in Table 1.

[0086]

[Table 1]

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	塗布液の組成 (wt%)						膜の光学特性		電気的特性
	6ホウ化物		ITO	ATO	バインダー		可視光透過率 (%)	日射透過率 (%)	表面抵抗値 (Ω/\square)
	種類	濃度	濃度	濃度	種類	濃度			
実施例 1	LaB ₃	0.09	14.5	0	紫外線硬化	20	78	55.6	$>1 \times 10^5$
実施例 2	LaB ₃	0.12	8.66	0	紫外線硬化	20	78	54.2	$>1 \times 10^5$
実施例 3	LaB ₃	0.18	7.68	0	紫外線硬化	20	78	54.7	$>1 \times 10^5$
実施例 4	LaB ₃	0.21	6.18	0	紫外線硬化	20	78	57.5	$>1 \times 10^5$
実施例 5	LaB ₃	0.33	2.75	0	紫外線硬化	20	78	59.3	$>1 \times 10^5$
比較例 1	LaB ₃	0	17.0	0	紫外線硬化	20	78	57.8	$>1 \times 10^5$
比較例 2	LaB ₃	0	0	9.5	紫外線硬化	20	78	63.1	$>1 \times 10^5$
実施例 6	LaB ₃	0.09	0	8.06	紫外線硬化	20	78	62.5	$>1 \times 10^5$
実施例 7	LaB ₃	0.27	0	4.15	紫外線硬化	20	78	61.3	$>1 \times 10^5$
実施例 8	LaB ₃	0.37	0	3.16	紫外線硬化	20	78	61.0	$>1 \times 10^5$
実施例 9	LaB ₃	0.38	0	2.38	紫外線硬化	20	78	62.0	$>1 \times 10^5$
比較例 3	LaB ₃	0	0	23.0	紫外線硬化	30	60	40.2	$>1 \times 10^5$
実施例 10	LaB ₃	0.22	0	19.7	常温硬化	25	60	37.0	$>1 \times 10^5$
実施例 11	LaB ₃	0.29	0	15.7	紫外線硬化	30	60	35.0	$>1 \times 10^5$
実施例 12	LaB ₃	0.52	0	15.5	紫外線硬化	30	60	32.5	$>1 \times 10^5$
実施例 13	LaB ₃	0.69	0	8.28	紫外線硬化	30	60	32.7	$>1 \times 10^5$
実施例 14	LaB ₃	0.77	0	6.66	紫外線硬化	30	60	33.0	$>1 \times 10^5$
実施例 15	LaB ₃	0.84	0	5.24	紫外線硬化	30	60	33.0	$>1 \times 10^5$
実施例 16	LaB ₃	0.82	6.94	0	紫外線硬化	30	60	31.0	$>1 \times 10^5$
実施例 17	CeB ₃	0.19	7.70	0	紫外線硬化	20	77	53.8	$>1 \times 10^5$
実施例 18	PrB ₃	0.20	7.50	0	紫外線硬化	20	77	54.1	$>1 \times 10^5$
実施例 19	NdB ₃	0.51	0	14.5	紫外線硬化	33	59	33.0	$>1 \times 10^5$
実施例 20	GdB ₃	0.60	0	12.3	紫外線硬化	34	60	34.5	$>1 \times 10^5$
実施例 21	YB ₃	0.17	7.0	0	紫外線硬化	20	78	54.0	$>1 \times 10^5$
実施例 22	SmB ₃	0.80	0	6.51	紫外線硬化	33	60	34.1	$>1 \times 10^5$
実施例 23	EuB ₃	0.82	0	6.50	紫外線硬化	33	60	34.3	$>1 \times 10^5$

[0087]

[Effect of the Invention] As shown above, according to this invention, the fault of an ingredient is solved conventionally [above-mentioned]. It is the permeability of the light of a light field being high, a reflection factor's being low, and the permeability of the light of a near infrared region being low, being able to cover the heat energy of solar radiation efficiently, without spoiling brightness, and using ATO, and ITO and 6 borides collectively. Rather than each independent use, raise a solar radiation electric shielding property, decrease ATO and the amount of ITO used, and ingredient cost is reduced. And coating liquid for the more controllable film than [106ohms /] ** to form a membranous surface-electrical-resistance value by the simple applying method, without using the physical forming-membranes method and the solar radiation screen using this have been offered.

[0088] It is effective in reducing the cooling load of summer by using this film for windowpanes, such as a building, and is useful also to energy saving, and usefulness is high also in environment.

[Translation done.]